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Ruidoso Wastewater Treatment Plant Project
Analysis of the Ongoing Phosphorus Problem

Prepare For Dr. Richard Seely by Richard Burton,
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It is clear that the Village of Ruidoso needs to review its options before starting the head works or any other construction on a new treatment plant because of the ongoing phosphorus problem. As you know, most phosphorus removal plants that use biological processes have a limit of 2-3 ppm. Chemical addition typically brings this down to about 1ppm. I have discussed the matter with one engineer in Pennsylvania who said that they are meeting a 0.2 ppm limit with chemical addition and filtration.

The Preliminary Engineering Report needs to begin with ways to reduce the phosphorus level upstream. I know the latter is the focus of Village activities at the present time. We recommend, for example, that if the golf course is the culprit, it should be fairly easy to build a catch basin for the irrigation and rainwater and treat this water for phosphorus removal by a biological method. We researched this and found several systems that could be applicable. One method is a reed bed that could become a part of the golf course landscaping. These beds have been tried in various places and are of course more efficient in warmer climates. The most northerly one we found is in Montreal, Canada. They claim 64% removal of phosphorus with the additional benefit of 60% nitrogen removal. These numbers will vary with the contaminants in the drainage water, but this is an inexpensive way to solve the problem and could lead to a change in the discharge permit. The Lasis Companies in Taos have studied similar systems and I think that this is a project that they would be interested in.

A second solution would be to find another point of discharge. It would certainly seem reasonable to pump the effluent to an alternative location or another point further down stream.

I recommend that the Engineer be instructed to consider the following alternatives.

1) Reduce the other sources of phosphorus so that the phosphorus in the discharge permit can be higher. There are reasonable, inexpensive solutions if the level can be raised to 2 - 3 ppm.

2) See if the Village efforts to reduce the permit limits are successful. If the permit can be changed to allow 98% removal of nitrogen and 60% removal of phosphorus, the existing plant can be inexpensively modified to remove contaminants to these levels.

3) I would try to avoid chemical addition solutions. They are extremely expensive. They produce a chemical sludge. They cannot be used in conjunction with nitrogen removal.

4) Before millions of dollars are spent on a new plant, several other alternatives should be considered.

a) Reuse of wastewater for irrigation and/or winter snowmaking.
b) Pump wastewater to any area that has less stringent discharge requirements, such as crop irrigation, constructed wetland sites, etc.

Technical Notes:

At the outset, phosphorus occurs in wastewater at 4-15 ppm with a common number of around 10 ppm. The EPA has set the discharge permit limit in Ruidoso at 0.1 ppm. This is 99% removal. There are two basic ways to remove phosphorus. One is by biological removal and the other is by chemical addition with precipitation and/or filtration. There are a lot of variations of these two basic processes.

Microbes utilize phosphorus during synthesis and energy transport and as a result, 10 - 30% of the phosphorus is removed by the mechanical biological (secondary) treatment such as activated sludge or extended aeration. I believe the existing plant in Ruidoso could be removing up to 30% of the phosphorus.

When enhanced phosphorus removal is needed, the process is modified so that the sludge is exposed to both anaerobic and aerobic conditions. This is a two-step add-on for secondary plants.

The Anaerobic Step Under anaerobic conditions, facultative bacteria will release soluble phosphorus into the water and absorb BOD. The absorbed BOD is stored until it can be utilized under aerobic conditions. The released phosphorus comes from adenosinetriphophate (ATP) that is a stored energy form inside the bacterial cell. The bacteria break the phosphate bonds of the ATP to obtain enough energy for absorbing the BOD.

The Aerobic Step Following the anaerobic step, the bacteria begin to oxidize the stored BOD under aerobic conditions. The stored BOD is usually in the form of polyhydroxybutyrate (PHB). PHB is a form of stored carbon that shows up as an intracellular inclusion. Also during the aerobic step, the bacteria rebuild the stored energy ATP. To rebuild the ATP, they remove soluble phosphorus from the waste stream. If the bacteria are conditioned to an anaerobic/aerobic cycle, the phosphorus uptake rate in the aerobic zone can be very high. Very high means about 60% removal.

So the biological processes will produce a 30% reduction at the secondary level and 60% reduction at the tertiary level 10-.3(10) = 7 ppm and 7-.6(7) = 2.8 ppm. We have a total of 72% reduction and can expect to discharge 2.8 ppm phosphorus. The obvious conclusion is that you cannot meet or even approach the permit limit with the biological phosphorus removal process.

The next option is chemical addition and precipitation, and possibly filtration. Phosphorus in wastewater occurs as orthophosphate (30%), polyphosphate (35%), and organically bound phosphate (35%). Phosphate can be removed by various multi-valent metal ions, calcium, aluminum, iron, etc. Lime can be used in water that has natural bicarbonate alkalinity, but most treatment plants use either aluminum sulfate or ferric chloride.

There are different points in the treatment process where chemical addition can take place. Chemical addition, as the primary step, seems to be the most efficient way to eliminate phosphate, but it will increase the volume of primary sludge to be handled. It may interfere with thickening chemicals used in the solids handling system. It does reduce the load on the secondary system, but I think that the excess sludge is counter productive. It has to be disposed of in a landfill and it can contain high aluminum levels. You are solving one problem and creating another.

We agree with the plant schematic that shows chemical phosphorus removal near the end of the process. The schematic does not show filtration after the chemical phosphorus removal. The best numbers we can find for chemical removal of phosphorus without filtration are in the 60% to 70% range. The most optimistic discharge level will be around 1.0 ppm or 10 times the Village permit limit. Even if they add filtration and can get down to 0.2 ppm. The Village will have spent 20 million dollars and <u>will not</u> meet their permit limit.

I think that when regulatory agencies set seemingly impossible conditions, it is essential that engineers find creative solutions to the problem. In this case, it is simply not possible to discharge the wastewater in this section of the Rio Ruidoso. It is foolish to take the attitude that we are going to do the best we can and discharge anyway. There are two solutions: 1) get the permit changed, or 2) discharge somewhere else.